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Spacecraft Beacon Monitoring for Efficient Use of The Deep Space Network

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The NASA Deep Space Network (DSN) is preparing to experiment with a new way of supporting highly autonomous missions. The spacecraft will have on-board intelligence to determine whether it is healthy and when ground contact is needed. It will transmit one of 4 messages to the ground instead of normal full engineering telemetry of the spacecraft health. These messages will be monitored by a ground station. Based on the urgency of the message, the DSN will schedule an antenna to receive telemetry. Deep space missions traditionally schedule ground antennas to receive engineering telemetry up to several times per week. This new approach can reduce the monitoring time to a few minutes per day and engineering telemetry once every several weeks. This approach is being consider-cd for use on upcoming missions to Europa and Pluto and possibly other missions.

This monitoring concept requires a higher degree of on-board intelligence than before. It also requires an automatic ground monitoring system to detect and decode the 4 state messages. Both are under development and will be demonstrated with the first New Millennium Deep Space One (DS-I) mission. The DSN is developing an experimental monitoring system and an operational strategy to support the experiment. Operational performance will be observed and evaluated for 9 months during the mission, beginning shortly after launch in July of 1998. Cost benefits will be assessed at the end of the experiment.

The DSN has conducted studies to develop an end-to-end system design and operational strategy for this monitoring concept. Alternative ground implementation approaches using different signaling and detection schemes and ground antennas have been studied. Since only a small set of messages are transmitted, it is possible to devise a signaling and detection scheme with a threshold a factor of 10 lower than the existing DSN schemes. The lower threshold allows weaker signals to be detected, which enables support of spacecraft at longer distance or use of smaller ground antennas. The economy of ground implementation options however depends on the availability of existing 34-meter antennas, the number of spacecraft to be monitored, and the signal strengths of these spacecraft. For a small number of user spacecraft, the approach that uses existing DSN 34-meter antennas and existing DSN signaling and detection schemes offers the lowest total cost. Other methods have a cost advantage when the number of user spacecraft is large

This paper describes the experiment, end-to-end system design, operational scenarios, performance of the ground monitor, and cost benefits of implementation options using different signaling schemes and ground antennas.